A COMPARATIVE STUDY OF NESTING BIRDS IN A FIVE-ACRE PARK

Howard Young

THIS paper presents quantitative data on the size and nesting success of a breeding population of birds in a five-acre park land area; it traces the changes in this population and its reproductive fortunes through a complete breeding season, and compares the breeding cycles, the nest density, and the success of the various species composing it.

The material is based on observations made during the spring and summer of 1947 at Ho-Nee-Um Pond, a small portion of the University of Wisconsin Arboretum, in the vicinity of Madison, Wisconsin. By means of frequent searches (almost daily in spring, later about twice a week) a high percentage of the nests on the area was found, and it was possible to trace the history of most of these through the nesting cycle. Approximately 250 man-hours were spent in the field. Mean temperatures for the study period averaged 2.2 degrees below normal during March through July. August was the hottest ever recorded for the Madison region, 8.8 degrees above normal, and September was slightly above normal. Precipitation for the study period was 2.89 inches above normal.

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Description of the Area

The Ho-Nee-Um Pond area (Fig. 1) is a low-lying park on the northwest shore of Lake Wingra. It is roughly trapezoidal in shape and has an area of 5.2 acres. The 2 main plant communities are a mowed lawn of blue grass (*Poa spp.*) covering about 40% of the total area, and numerous plantings of closely spaced arbor vitae (*Thuja occidentalis*), covering about 26% of the total area. These plantings are arranged in irregular patterns, making for extensive environmental edges with the grass area.

The arbor vitae varies in height from 5 to 30 feet, with the average tree about 15 feet high. Mixed with it are scattered patches of red osier dogwood (*Cornus stolonifera*) and staghorn sumac (*Rhus typhina*), and lesser amounts of white birch (*Betula alba*), elderberry (*Sambucus canadensis*), ninebark (*Physocarpus opulifolius*), box elder (*Acer negundo*), honeysuckle (*Lonicera tatarica*), hawthorn (*Crataegus sp.*), and highbush cranberry (*Viburnum opulus*). The ground cover under the plantings is mainly blue grass, nettle (*Urtica sp.*), thistle (*Cirsium sp.*), and burdock (*Arctium sp.*). The vegetation beneath the arbor vitae was cut once, in May, with scythes. Late in the season there were solid beds of swamp milkweed (*Asclepias incarnata*) along some of the edges.

The northeastern corner of the area contains a small group of black locust (*Robinia pseudo-acacia*). The lake shore is lined by occasional cottonwoods

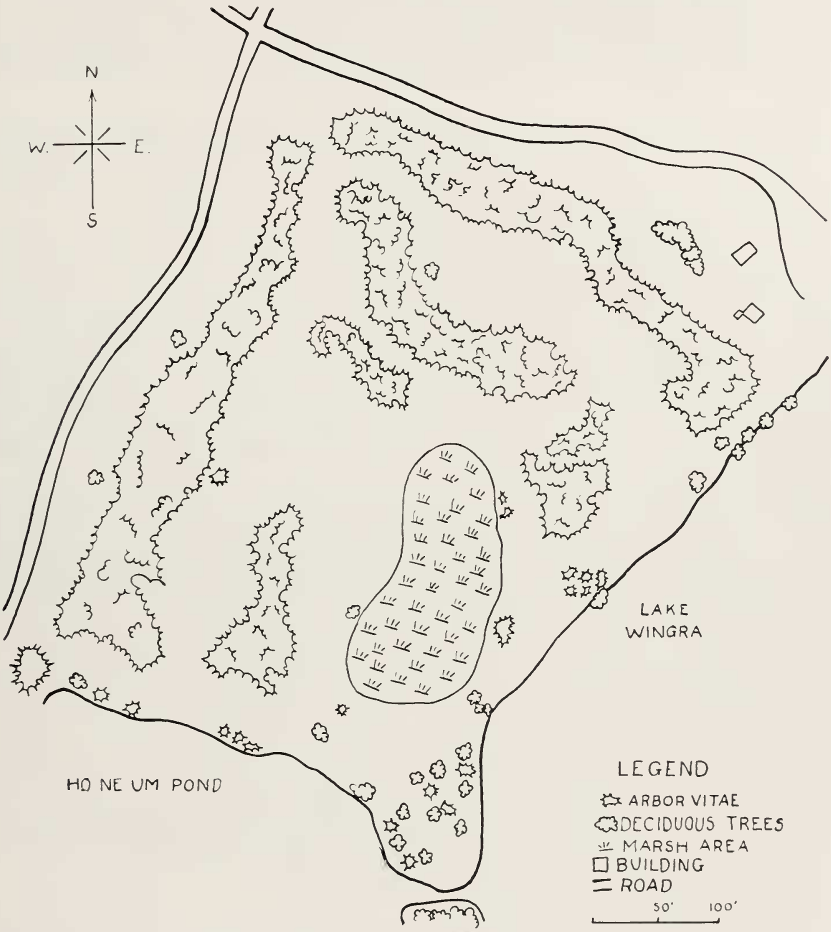

FIG. 1. Ho-Nee-Um Pond Area and Vicinity

(*Populus deltoides*), and there is a thick clump of black willow saplings (*Salix nigra*) in the southwest corner. Near these is a small swampy pond of approximately .3 acres, thickly grown to sedge (*Carex sp.*), with a few patches of cattail (*Typha latifolia*) and reed grass (*Phragmites communis*). The grass contains liberal amounts of dandelion (*Taraxacum officinale*) and plantain (*Plantago major*).

Nest Density and Nesting Chronology

The nesting population of the area is summarized in Table 1. Unless otherwise designated all the data refer to "active" nests (those in which at least one egg was laid). In addition to the species listed, the Cowbird (*Molothrus ater*) bred as a parasite of the Alder Flycatcher, Cedar Waxwing, Yellow Warbler, Rose-breasted Grosbeak, and Song Sparrow. Figure 2 presents the same material in graphic form; in this case, however, only nests actually found were considered.

The high density, ranging up to 9.6 nests per acre (May 19–May 20) is considered of special interest. This is probably due to the great interspersion of plant types, and the large amount of "edge" as shown in Figure 1. There are approximately 5000 feet of arbor vitae-grass edge in the area.

Computed according to the usual manner, i.e., the total number of nests on the area during the season, the density was 164 nests, or 32.8 per acre. This is referred to as "Total Nest Density" in Table 1. These nests represent approximately 94 breeding pairs, a density of 18.5 per acre. Steinbacher (1942) found 111 pairs of birds nesting in the 19 acre Frankfort Zoo park. This density of 5.8 pairs per acre, while only one-third that of Ho-Nee-Um, was considered to be especially high. There do not appear to be other comparable studies in areas of similar size for comparison.

The density data were further analyzed by comparing them from month to month. This showed extensive fluctuations as some species ended their nesting and others started (Figure 2). Following are the average daily densities in nests per acre for the months covered by this study: April—3.5, May—8.6, June—6.0, July—4.8, Aug.—2.1, Sept.—.6. The overall average was 4.3 nests per acre.

It would seem that "Highest Nest Density" (Table 1–D) has a particular significance. Other workers have usually computed what is shown in Table 1 as "Total Pair Density" (Col. F) and "Total Nest Density" (Col. C). These are valuable as indices to the population, but computing the highest nest density has the advantage of showing the greatest nesting population at any one time, and as such is better suited for investigations of the various problems related to social competition such as density tolerance, density-induced behavior, reproductive success, etc.

Inter-specific strife was very low even during the periods of highest density. Of the two most abundant species, Bronzed Grackles and Robins, the Grackles exhibited no recognizable territorial behavior; Robin territories were poorly defined and defended with indifferent vigor (Young: 1947). The other species were not observed sufficiently to draw conclusions regarding territorial behavior.

In Figures 2 and 3, the numbers and stages of the nests shown were determined partly by daily examination, and partly by interpolation and extrapolation. Nests in various stages of the cycle were followed, and averages based on all records were determined for the length of time in each phase. When a new nest

TABLE 1
Species Nesting at Ho-Nee-Um Park, 1947

SPECIES	A	B	C	D	E	F
	Nests found	Estimated total of nests	Total nest density	Highest nest density	Total no. of pairs (estimated)	Total pair density
Bronzed Grackle *Quiscalus quiscula*	26	28	5.6	4.2	21	4.2
Robin *Turdus migratorius*	36	37	7.4	3.8	19	3.8
Catbird *Dumetella carolinensis*	22	22	4.4	2.2	11	2.2
Cedar Waxwing *Bombycilla cedrorum*	14	16	3.2	1.6	8	1.6
Yellow Warbler *Dendroica petechia*	12	12	2.4	1.4	7	1.4
Goldfinch *Spinus tristis*	9	9	1.8	1.2	6	1.2
Song Sparrow *Melospiza melodia*	2	15	3.0	.5	5	1.0
Mourning Dove *Zenaidura macroura*	11	11	2.2	1.0	5	1.0
Alder Flycatcher *Empidonax traillii*	5	5	1.0	.6	3	.6
Mallard *Anas platyrhynchos*	1	2	.4	.2	2	.4
R. N. Pheasant *Phasianus colchicus*	2	2	.4	.2	2	.4
Killdeer *Charadrius vociferus*	1	1	.2	.2	1	.2
Rose-Br. Grosbeak *Pheuticus ludovicianus*	1	1	.2	.2	1	.2
Chipping Sparrow *Spizella passerina*	1	1	.2	.2	1	.2
Warbling Vireo *Vireo gilvus*	0	1	.2	.2	1	.2
Yellowthroat *Geothlypis trichas*	0	1	.2	.2	1	.2
Total........................	143	164	32.8	9.6	94	18.5

C & F computed from B & E.
D—highest density at any one time; computed from A.
C, D, & F computed on a per-acre basis.

was found it was thus possible to determine fairly accurately the date on which it was started. For example, observations showed that Robins took about 7 days on an average to build their nest; it then remained empty for an average of 4 days, after which the eggs were laid at the rate of 1 a day. A Robin nest found to contain 2 eggs on April 20 was therefore tallied as having been started on April 7, since 13 days were necessary to bring it to the 2-egg phase of the cycle. In most cases it was only necessary to extrapolate 3 or 4 days. About 35% of the material presented in the figures was thus computed.

The efficiency of nest searches was tested by comparing the extrapolated totals of any given day with the number of nests actually known on that day. On this basis it was found that the number known on any given day varied from 32%

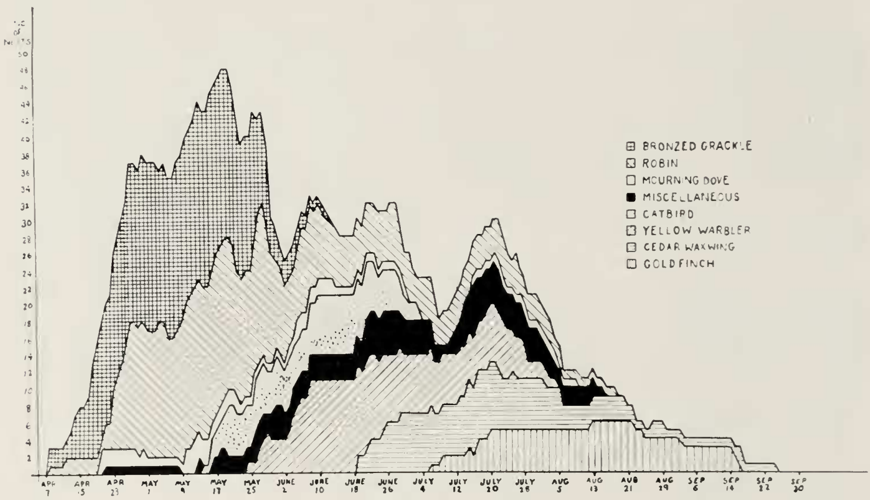

FIG. 2. Ho-Nee-Um Nests, 1947

to 100% of the number actually present. This does not take into consideration nests of Song Sparrows, since time did not permit extensive searches for them, and only 2 were found. On the peak days, May 19–20, 88% of the nests had been located. Comparison of the number of nests found with the estimated total of nests in Table 1 shows that about 87% of all nests were eventually found. In view of these facts the writer believes that Figure 2 represents a fairly accurate graph of the nesting. Errors in extrapolation would push individual peaks and depressions 1 or 2 days in either direction, but these would tend to compensate for each other, and the general picture would remain the same.

Three major peaks in nesting density are discernible in Figure 2; late May (mainly Robins and Grackles), most of June (Robin, Catbird, Yellow Warbler and Cedar Waxwing), and mid-July (Catbird, Waxwing, Goldfinch). The meagerness of the data prevents extensive discussion, but a few interesting things may be pointed out. The overlapping nesting periods of Robins and Grackles, both using the same nesting sites (arbor vitae), makes them competitors. Cedar Waxwings also nested almost exclusively in arbor vitae, but did not start until the Grackles were gone and Robin nesting was much diminished. The Goldfinches and Yellow Warblers nested mainly in ninebark; there was about a two week overlap in their nesting periods. It is impossible to say how much competition for nesting sites affected the density of the various species; as previously mentioned, little interspecific strife was observed.

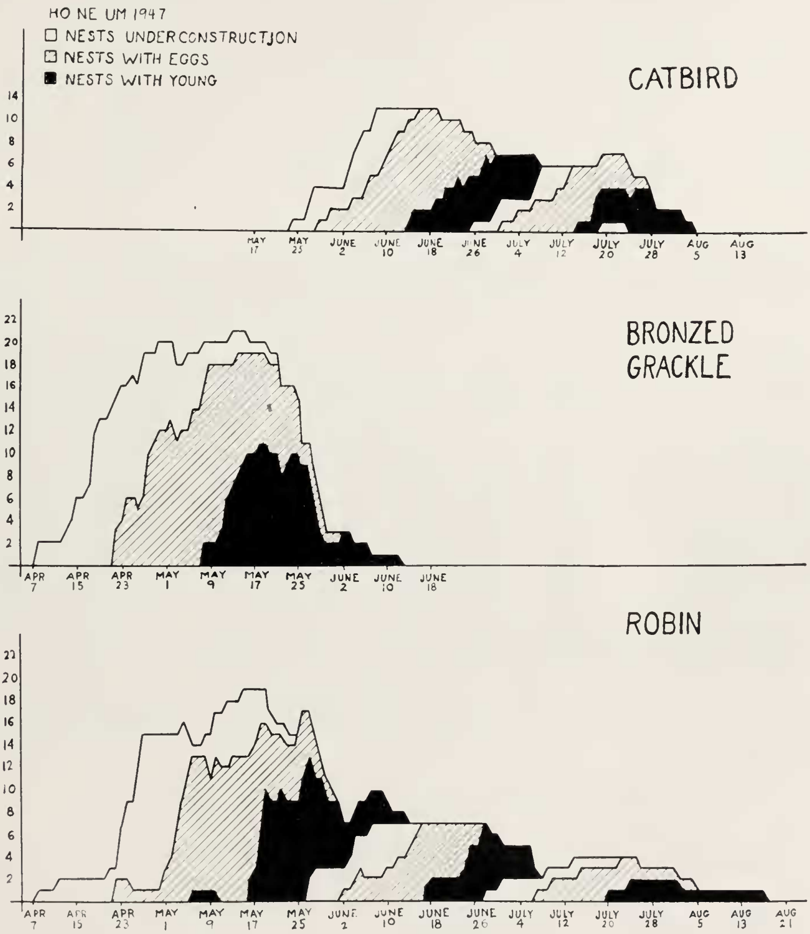

FIG. 3. Comparative Nesting Cycles, 1947

Figure 3 compares the nesting cycles of the 3 most abundant species at Ho-

Nee-Um. It demonstrates the "Highest Nest Density" discussed before and makes possible comparisons, as between the Robins and Grackles. More Robins nested on the area than Grackles (Table 1), but their nesting was spread over a much longer period, and at no time did they attain a density as high as that of the Grackle's peak. The graph of the Grackles, which are single-brooded, lacks the long "tail" characteristic of the other species. More than half of the Grackle nests were broken up, and it would seem that the lack of a "tail" on their graph indicates that either no renesting attempt was made, or that the birds moved entirely off the area for the next attempt. Part of the sharp fall in the number of Robin nests after May can possibly be explained by the scarcity of hardwood trees on the area. Howell (1942: 549) found that 57% of the Robin nests he studied were built in conifers during the first nesting period, but later, when the

TABLE 2
Ho-Nee-Um Nesting Data, 1947

	A	B	C	D	E	F	G	H	I
SPECIES	Active nests	Successful	% Successful	Eggs per nest	% Hatched	Fledglings per nest	% Eggs producing fledglings	% of young fledging	Av. success of productive nests
Bronzed Grackle	26	12	45	4.5	72	4.3	44	61	84
Robin	36	18	50	3.3	61	2.4	37	61	73
Catbird	22	12	55	3.1	65	2.9	51	79	92
Cedar Waxwing	14	8	57	3.9	54	2.6	39	72	77
Yellow Warbler	12	5	42	3.5	48	2.8	33	70	74
Mourning Dove	11	2	18	1.8	30	2.0	20	66	100
Totals and averages	121	57	47	—	61	—	40	66	81

D computed from A; F computed from B.
B—Nests producing at least 1 young.

hardwood trees had leafed out, the number of Robins found nesting in conifers fell to 38%.

Nesting Success and Causes of Failure

Table 2 compares the nesting data of the various species for which at least ten nests were found. Again the small number of nests precludes intensive analysis of the figures, but some basis for comparison of nesting success is available.

Comparison of the percent of eggs hatching (E) with the percent of young fledging (H) shows a differential effect of environment on the various species under consideration. The Robins suffered losses approximately equal during the egg stage and the nestling stage. Catbirds and Grackles were affected in directly opposite fashion, the former having a heavier loss during the egg stage, the latter during the nestling stage. In the case of the Grackles, a bad storm when there were many small young in the nest accounted for much of the mortality.

The same comparison also indicates that the species having the poorest success in hatching eggs generally had a proportionately greater success in fledging their young. It is interesting to note that in comparing success from year to year, Nice's (1937: 141) figures for the Song Sparrow show the same general pattern within a single species. In her Table XVI, by dividing the number of fledglings by the number of hatched eggs, the following figures are obtained:

Year	*% of Eggs Hatching*	*% of Young Fledging*
1930	68%	63%
1931	72%	63%
1932	61%	61%
1933	51%	37%
1934	35%	78%
1935	41%	71%

The non-conformity of 1933 is apparently due to plowing of the nesting area at a time when most of the nests contained small young. Very close correlation should not be expected, since there are many other factors besides hatching success which could influence the fledgling success.

A similar situation is suggested in a study of the Eastern Red-winged Blackbird (*Agelaius phoeniceus*) by Smith (1943: 190). Of two nesting Red-wing populations, "A" hatched 74% of 563 eggs and fledged 80% of the young, "B" hatched 70% of 577 eggs and fledged 84% of the young. Much more data is needed for statistical testing, but it appears that there is possibly a compensatory interaction here following the general pattern that low egg survival results in high nestling survival, or conversely, that high nestling survival is associated with low egg survival. Errington (1946: 170) used Smith's data to illustrate the effects of predation, showing that a high loss of eggs apparently resulted in reduced vulnerability of the nestlings to predation. Another factor possibly involved is competition between nestlings, which Emlen (1942: 151) considered a major factor in nestling survival in the Western Crow.

Comparison between species of reproductive success, based on the number of young fledged per pair or per nest, will always be affected by the varying clutch size among the different species, and the varying number of broods raised. These factors can be eliminated by comparing the percent of eggs producing fledglings (Table 2–G). Considering each egg as a reproductive attempt, this shows what percent of the reproductive potential is attained. On this basis Catbirds were the most successful breeders at Ho-Nee-Um, (51% of their eggs producing fledglings) while Mourning Doves were the least successful, (only 20% of their eggs producing fledglings). The average success of productive nests (Table 2–I) was computed by dividing the number of fledglings by the number of eggs. The Mourning Dove nests were either complete failures or total successes, reflecting the birds' quickness to desert when molested. On the other hand, the Robins were able to bring off broods successfully after disturbances, though in only a few cases were their nests 100% successful.

Reproductive success possibly has the same inverse correlation with density as shown for reproductive activity by Kendeigh (1934: 308). Smith (1943: 204) found no evidence of this in the Red-wing, but Errington (1945: 14) found an inverse ratio between spring density and summer population gain of the Northern Bob-white (*Colinus virginianus*). Now that nesting studies have become more common it should be possible to compile similar data on various species from several areas. The value of these would be enhanced if it were also possible to compare the densities of the different areas, but this information is seldom available. More intensive studies might show optimum densities for

TABLE 3
Nest Success in Various Studies

SPECIES	NESTS	SUCCESSFUL %	REFERENCE	LOCATION	YEAR
Robin	501	78	Kendeigh, 1942	Ohio	?
	136	61	Howell, 1942	N. Y.	1937–38
	64	77	Koehler, 1945	Wisc.	1945
	36	50	This study	Wisc.	1947
	16	13	Thomsen, 1944	Wisc.	1944
Catbird	142	70	Kendeigh, 1942	Ohio	?
	22	55	This study	Wisc.	1947
Cedar Waxwing	29	58	Kendeigh, 1942	Ohio	?
	14	57	This study	Wisc.	1947
	12	50	Lea, 1942	Mich.	1940–41
Yellow Warbler	25	80	Kendeigh, 1942	Ohio	?
	16	75	Kendeigh, 1941	Iowa	1940
	12	42	This study	Wisc.	1947
Mourning Dove	2877	48	McClure, 1946	Iowa	1938–40
	325	47	McClure, 1946	Nebr.	1941–43
	57	54	Kendeigh, 1942	Ohio	?
	11	15	This study	Wisc.	1947
	10	70	McClure, 1946	Calif.	1944

the different species, such as has been shown for various invertebrates by Allee (1931: 161–180).

Nice (1937: 143) postulates 40% to 46% as typical success for open nests of passerines in the North Temperate Zone. At Ho-Nee-Um the passerine species averaged 49.8% successful in nesting attempts, a figure which agrees quite well with her estimate.

Table 3 compares the nesting success at Ho-Nee-Um with that of the same species in other areas. No references were found for the Bronzed Grackles, and again the species are limited to those for which at least 10 nests were found at Ho-Nee-Um. The data of Kendeigh (1942) were adjusted to make them conform to "active" nests as defined in this study. Unfortunately, information on density was not given in the other studies, but the consistently low success at

Ho-Nee-Um (excepting Cedar Waxwings) is possibly a reflection of its high nesting density. However, such a comparison suffers from the fact that the other studies sometimes covered several years, and were from many different area types. Omitting the Ho-Nee-Um data, the nest success of the passerine species listed in Table 3 averages 74%, nearly double Nice's estimate for open nesting of passerine birds.

TABLE 4
Nest Failures Ho-Nee-Um, 1947

	SPECIES							
	Bronzed Grackle	Robin	Cat-bird	Cedar Wax-wing	Yellow Warbler	Mourn-ing Dove	Total	Per cent
Nest failures								
A Predation	4	7	7	3	2	6	29	45
B Desertion	8	6	3	2	4	2	25	39
C Weather	2	5	0	1	1	1	10	16
D Total	14	18	10	6	7	9	64	100
Eggs not hatching								
A Predation	19	14	20	8	11	12	84	52
B Desertion	2	15	2	8	5	2	34	21
C Weather	0	6	0	0	0	0	6	4
D Unaccounted	9	4	0	2	1	0	16	9
E Infertile/addled	3	7	2	7	5	0	24	15
F Total	33	46	24	25	22	14	164	100
Young not fledging								
A Predation	0	10	7	1	0	0	18	21
B Desertion	9	3	0	1	0	0	13	15
C Weather	17	8	0	2	0	2	29	34
D Unaccounted	5	7	2	2	0	0	16	18
E Fell from nest	1	1	0	1	3	0	6	7
F Died in nest	1	0	0	1	0	0	2	2
G Cowbird parasitism	0	0	0	0	3	0	3	3
H Total	33	29	9	8	6	2	87	100

All nest failures could be attributed to one of 3 causes: predation, desertion, or storm damage. The effect of these on the species studied, referring only to "active" nests, is shown in Table 4.

Two Robin nest desertions were directly due to activities of the observer. Three Robin eggs, 1 Grackle egg, and 1 Yellow Warbler egg were accidentally broken; they were listed as lost due to predation. As far as could be determined the activities of the study had no other effect upon the species under consideration.

The predation was nearly 100% by an unknown avian form which punctured the eggs in the nest. Bronzed Grackles were suspected, but were never seen at the nests of other species, or carrying their eggs or young. The Grackles were common on the area from late March to late June, but egg losses continued at about the same rate after their departure. If a predator took 1 egg out of a clutch and the owner deserted, the remainder of the eggs were listed as lost due to desertion. Predation on adult birds was not observed, and its extent is not known. However, it probably does introduce an error in the records on deserted nests, since some of the resident birds may have disappeared because of predation rather than because they deserted.

Predation was the chief cause of nest failure, operating most strongly during the egg stage. Weather of course would act differently on the various species from year to year, depending upon the time that bad storms happened to occur.

Summary

Nesting birds were studied in a five-acre park area with arbor vitae and bluegrass lawn as the main cover types.

A total of at least 15 species (94 pairs) bred on the area during the period of study.

May and June were the months of highest nest density. On May 19–20 there were 9.6 active nests per acre. The average number of nests per acre for the season was 4.3. The total density for the season was 32.8 nests per acre.

The high density did not produce any noticeable interspecific strife.

Catbirds were the most successful breeders, producing fledglings from 51% of their eggs; Mourning Doves were the least successful, producing fledglings from 20% of their eggs.

Those species suffering the greatest loss of eggs in the nest generally appeared to be the most successful in raising nestlings.

Predation by an unknown avian form was the main cause of nest failures.

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Zoology Department, Univ. of Wisconsin, Madison, Wisconsin.

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